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HOW TO FIGHT THE EUROPEAN CORN BORER THIS FALL¹

D. J. CAFFREY, Entomologist, Corn-Borer Investigations, and L. H. WORTHLEY,
Administrator in Corn-Borer Control, Bureau of Entomology

The critical season of damage by the European corn borer (fig. 1) is now at hand. Early-season reports from the Lake Erie region show an alarming increase in borers as compared with 1925. There has also occurred during the present season an important spread into new territory, bringing the pest as far westward as eastern Indiana.

A previous circular² explained certain important methods for reducing the present infestation and preventing further losses and discussed briefly the habits of the borer, the methods of quarantine enforcement to prevent long-distance spread of the pest through transportation of infested products, scouting methods for discovering new infestations, and similar information.

The present circular is intended to assist the corn growers in planning the harvest of the crop and the disposal of corn residues in such a manner that the borer may be held in check.

PLOWING AS A MEANS OF CONTROL

Recent field experiments conducted by the Bureau of Entomology in the Lake Erie region have demonstrated the value and necessity of plowing under cornstalks and stubble as a means of corn-borer control. The effectiveness of plowing depends upon turning under the corn refuse and other plant debris so completely that none of it remains upon the soil surface. It requires also that the material shall not be dragged to the surface by later cultivation.

Clean plowing is the best practical method of control for application to fields containing high stubble or stalks in case it is impracticable to cut the stalks close to the ground and dispose of them by feeding or burning. Existing methods of cutting stalks or breaking them off at the soil surface, raking them into windrows, and burning them are less effective than clean plowing alone, except where such raking and burning are followed by plowing under the remaining debris.

In the Bono-Reno area of northwestern Ohio during May and June,

1925, the number of borers per acre remaining in cornfields which had been poled, raked, and burned, or disked for small grain, was nearly twice as great as the number remaining in fields where cornstalks or stubble had been plowed under.

In disked corn-stubble fields where small grains were seeded the previous fall or in the spring, 89 per cent of the original borers remained alive in the corn remnants and other plant debris on the soil surface.

PLOWED FIELDS SHOW BEST RESULTS

Studies made in five plowed fields of Lucas County, Ohio, revealed that on an average 75 per cent of the borers were killed by the operation,

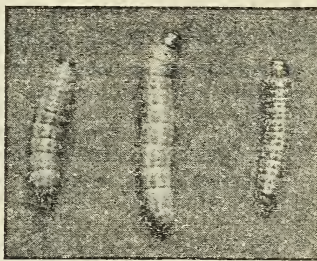


FIG. 1.—Larvæ, or caterpillars, of the European corn borer, slightly enlarged

although no special effort was made to plow under cleanly. Two of these fields contained standing stalks and three were in high stubble.

Similar field work at Silver Creek, N. Y., showed an average of 97 per cent of the borers killed in three fields where standing stalks were poled down and then plowed under. In three fields where high stubble was plowed under, an average of 78 per cent of the borers were killed.

Less than 10 per cent on an average were killed by winter conditions, predators, parasites, and disease.

POLED, RAKED, AND BURNED FIELDS SHOW ONLY FAIR CLEAN-UP

In the region previously mentioned an average of 59 per cent of the borers were killed by poling, raking, and burning the standing stalks in four

¹ Miscellaneous Circular No. 84, United States Department of Agriculture. Contribution from the Bureau of Entomology and the Federal Horticultural Board, U. S. Department of Agriculture, in cooperation with State departments of agriculture.

² Miscellaneous Circular No. 70, U. S. Department of Agriculture. Timely Information about the European Corn Borer, 8 pp., June, 1926.

fields. Many living borers were found in pieces of stalks not burned properly, as well as in stalks not broken off during the plowing process, and in stalks missed by the rake. Fourteen per cent of the borer population were left in small pieces of corn husk, leaves, etc., which it was not possible to gather with the type of rake ordinarily used for such purposes.

DISKED CORNFIELDS SHOW VERY POOR RESULTS

In four fields of high stubble where oats were seeded after disking, without previous cultivation, only 11 per cent of the borers were killed. Therefore, the seeding of small grain on disked corn stubble or stalks is a dangerous practice under corn-borer conditions, since it leaves so many of the borers alive. The growing grain also provides shade and ideal protection from the wind for the borers left in such fields during the late spring.

Regardless of any necessary change in farm practice, the disking for small grain on infested corn lands will have to be discontinued if the corn borer is to be held in check. Where unavoidable, this practice should be limited to fields in which the operations of cutting or breaking off the stalks at the soil surface and completely disposing of them together with all trash, by burning or otherwise, have been carefully conducted.

POLING, RAKING, AND BURNING, FOLLOWED BY PLOWING, VERY EFFECTIVE

In a field where standing stalks were poled down, raked in windrows, and burned, and the remaining debris plowed under, practically all of the borers were killed. Although there were about 5,100 borers per acre in the standing stalks before operations began, no living borers could be found in such small portions of trash as remained. This method, if widely adopted, would act as a very severe check on corn-borer infestation, and therefore it is strongly recommended.

AVERAGE PLOWING METHODS MUST BE IMPROVED

Although the plowing under of infested cornstalks and corn stubble has given encouraging results where carried on in a careful manner, it should be emphasized that *careless plowing leaves many pieces of stalks, stubble, weeds, etc., upon the soil surface* and is not effective. This debris shelters many borers which crawl to the surface after being plowed under. They bore into, or encase themselves, in such debris and here many of them transform into moths. Where such

shelter is lacking, the vast majority of the borers finally perish, either being eaten by birds, beetles, or ants, or killed by various native parasites or by exposure to the weather. The use of plows with wide bottoms and a chain or wire to aid in burying all debris is an important help in doing a clean job.

THE IMPORTANCE OF CLEAN PLOWING

The importance of clean plowing was strikingly shown by a series of experimental tests at Bono, Ohio.³

Infested cornstalks were plowed under at intervals from late September to mid-December, 1925, and surrounded by "recovery traps." At least 38 per cent of the borers in these plowed-under stalks crawled to the soil surface during the fall and the following spring. The remaining 62 per cent died in the soil or were destroyed by their natural enemies and weather conditions after reaching the surface.

In tests where the soil surface was practically free of all plant debris, an average of only 2 per cent of the plowed-down borers were able to find adequate shelter. In similar tests where the quantity of stalks on the soil surface was the same as on average fields in the vicinity, 13 per cent of the total borers plowed down found adequate shelter in debris on the surface. In two other tests where "recovery traps," which provided shelter, were placed 25 feet distant from the plowed area, and stalks were left on the soil surface in average quantity, 22 per cent of the total number of plowed-under borers succeeded in entering the surface debris. An additional 5 per cent crawled at least 25 feet to the "recovery traps." Thus it is shown that under circumstances closely imitating field conditions following clean plowing, only 2 per cent of the borers escaped destruction. On the other hand, where average quantities of corn remnants were left on the soil surface, from 13 to 22 per cent of the borers survived.

In certain small tests where minute examination was possible, evidence was obtained that 28 per cent of the borers had died in the soil.

CORNSTALKS IN BARNYARD, FEED LOT, AND MANURE MUST BE DESTROYED

The warning should be repeated against throwing large quantities of cornstalks and other corn remnants into the manure unless buried deeply within it. It is also dangerous to permit large quantities of cornstalks to accumulate in barnyards and feed lots. An examination of the corn-

³ Conducted in cooperation with L. L. Huber and C. R. Neiswander, of the Ohio Agricultural Experiment Station.

stalks in barnyards and on the surface of manure piles of five typical farms in Lucas County, Ohio, showed borers present in such cornstalks at the rate of 51 borers per 1,000 linear feet of stalks. No living borers were found in stalks buried deeply in the manure or in shredded corn plants which had been used for feed or bedding.

HUSKERS AND SHREDDERS VERY EFFECTIVE IN KILLING BORERS

The existing types of husking machines equipped with shredder heads or cutter heads, or combination shredder and cutter heads, kill most of the borers in infested cornstalks. The efficiency of the machines is increased where special care is taken to apply sufficient pressure on the snapping rolls to produce a crushing effect. In six tests wherein cornstalks infested by the corn borer were run through six different types of husking machines an average of 98 per cent of the borers were killed by the machine. The greater part of the remaining 2 per cent undoubtedly perished during the process of storing the shredded material, feeding it to livestock, and using the residue as bedding, ultimately to be trampled into the manure, as results from the general practice.

This method of disposing of fodder is strongly recommended and its use, in corn-borer territory, should be greatly extended.

The cutting box as ordinarily used has not proved effective in killing borers contained in cornstalks. If used at all, it should be adjusted so as to cut the stalks in pieces not to exceed one-half inch in length.

BORERS INCREASE MOST WHERE LARGE QUANTITIES OF STALKS ACCUMULATE

Judging from the history of the corn borer in Europe and in America, the pest may be expected to cause more damage in areas where the farming practices allow large quantities of stalks to remain undestroyed on farms than in areas where less corn is grown and stalks and other corn remnants are promptly consumed or destroyed. The real necessity for efficient clean-up operations in the infested parts of northwestern Ohio and southeastern Michigan is perfectly obvious, as here the large quantities of corn remnants carried over offer perfect shelter and abundant food for the borers.

POSSIBLE HELP FROM PARASITES

Popular belief leads many persons to suppose that all destructive plant

pests may be overcome by introducing, or encouraging, their natural enemies, especially their parasites. This method has been used with success in campaigns against many pests and is being given a very thorough test in the work against the European corn borer. As a first step, however, it was necessary to make careful studies of the parasites which prey upon the corn borer in its native European home, particularly in France, Italy, Belgium, and Hungary. These studies revealed several kinds of parasites that were helping to check the ravages of the pest in the countries mentioned. After determining that none of these parasites could by any chance become harmful to plants, they were sent to the United States and liberated, after proper handling, in fields where the corn borer was most numerous. Special precautions were taken, of course, to prevent the escape of natural enemies of the parasites (known as hyperparasites) when the parasites were liberated in this country.

Up to July 1, 1926, about 168,000 of these parasites have been liberated in the corn-borer-infested areas of Michigan, Ohio, Pennsylvania, and western New York. Five distinct kinds, or species,⁴ were used in this work and these were liberated in eight different places. Definite evidence has been obtained that one of these species started to prey upon the borer in western New York during 1924 and 1925, and in Ohio during the fall of 1925. It is hoped the others will follow suit.

Similar work in New England has resulted in placing about 1,187,000 parasites in infested cornfields of that section. Ten different kinds, or species, were used in New England and five of these species are known to be at work destroying the corn borer in that area.

PARASITES CAN NOT HARM PLANTS

The fact should be understood that none of these parasites can through any chance become harmful to plant growth.

PARASITES CAN NOT BE DEPENDED UPON TO CONTROL BORER

Although strenuous efforts are being made to import and establish parasites in the Lake Erie region, and in the other American areas infested by the corn borer, it is by no means certain that they will develop into effective aids in controlling the corn borer. In any event many years must elapse before any important effect can be expected. In the meantime every effort

⁴ *Exeristes roborator* Fab., *Microgaster tibialis* Nees, *Habrobracon brevicornis* Wesm., *Eulimneria crassifemur* Thom., and *Apanteles* sp.

should be expended to control the corn borer by the practical methods previously discussed, such as (1) cutting cornstalks early and close to the ground by hand or by means of corn binders provided with low cutting attachments, (2) feeding them to live-stock direct or placing them in the silo, (3) using husking and shredding machines, (4) plowing *cleanly*, and (5) burning all corn refuse.

CLEAN-UP REGULATIONS AS ADOPTED BY STATES IN LAKE ERIE REGION

The regulations promulgated by the Department of Agriculture in several States, relative to clean-up measures, have been drafted with the express object of accomplishing the control of the corn borer with as little extra effort on the part of each farmer as will still secure the desired results. A copy of these regulations follows. They are similar to those now effective in Canada and in Hungary, where severe losses have occurred and where conditions are very similar to those existing in the Corn Belt of the United States.

1. These regulations apply to the area as designated by the States each year.

2. All cornstalks, remnants of stalks, and cobs of each year's corn crop, in fields, buildings, stacks, or elsewhere, if not fed, made into silage, or shredded, shall be destroyed by burning or by plowing under completely, or by a combination of burning and plowing, before May 1 of the following year.

3. Cornfields or premises not properly cleaned by May 1 may be cleaned at the discretion of the director of agriculture and a charge made against the owner for the same.

Definitions: For the purpose of this regulation, cornstalks refer to the whole stalks or high stubble left standing in the field, or the portion of the stalks removed by cutting.

Cobs refer to cobs without corn.

Stubble 2 inches or less in height complies with requirements of the regulation.

Burning is interpreted to mean destruction with sufficient heat to destroy corn-borer larvæ.

Plowing under completely means leaving no débris whatever on the surface.

Cultivation after plowing that drags débris to the surface or the disking of stalks or high stubble does not meet the requirements of the regulation.

Recommendations: Early and low cutting is strongly urged and recommended, as by so doing the largest number of borers possible is removed from the field. All corn growers are advised to equip themselves with corn binders if possible and all owners of corn binders are advised to equip their machines with the low-cutting devices now available.

Low cutting is especially necessary in fields which are to be seeded to grain because high stubble contains many borers, and necessary suppression is not accomplished where such stubble remains.

Hogging-down corn and allowing stalks to remain in the fields over winter as a practice is condemned because it makes clean plowing difficult.

The above regulations will be promulgated by New York, Pennsylvania, Ohio, Michigan, and Indiana with such minor changes as may be necessary under each State law governing such operations.

It will be noted that the terms of the regulations give the farmer a

choice of several methods of disposing of cornstalks and corn refuse. The disking of cornstalks or high stubble is not allowed and other practices are suggested whereby the grower will not be dependent upon the disking method in the preparation of land for small grains. The reasons for each clause in the regulations are amply discussed in this circular and in Miscellaneous Circular No. 70, copies of which may be obtained by application to the Office of Publications, Department of Agriculture.

TRANSPORTATION OF ROASTING EARS

Quarantine operations are now being enforced in the stopping of automobiles to prevent roasting ears from leaving the infested area. Strict compliance with the quarantine provisions and the whole-hearted cooperation of all concerned are very necessary during this critical period. Early-season reports show that more borers are being found in the ears than during any previous season.

WHAT TO DO

**KILL BORERS
FOLLOW REGULATIONS
CUT LOW
FILL SILO
PLOW CLEAN
SHRED
BURN**

